

## Factsheet

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Replaces OMAFRA Factsheet 94-039, *Grassed Waterways*

### INTRODUCTION

Grassed waterways are broad, shallow and typically saucer-shaped channels designed to move surface water across farmland without causing soil erosion. The vegetative cover in the waterway slows the water flow and protects the channel surface from the eroding forces of runoff water. Left alone, runoff and snowmelt water will drain toward a field's natural draws or drainage ways. It is in these areas that grassed waterways are often established.



**Figure 1.** A grassed waterway would have prevented this erosion

If properly sized and constructed, grassed waterways safely transport water down natural draws through fields. Waterways also provide outlet channels for constructed terrace systems, contour cropping layouts and diversion channels. Grassed waterways are a good solution to the erosion caused by concentrated water flows when the watershed area generating the runoff water is relatively large.

As a guideline, consider establishing grassed waterways when working with watersheds greater than 20 ha (50 ac). For smaller watersheds, other structural controls such as water and sediment control basins, may be more appropriate (see OMAFRA

Factsheet *Water and Sediment Control Basins*, Order No. 89-167). If the areas contributing runoff are quite small, changes to tillage and soil management practices may be sufficient to control the erosion concern. Field practices such as conservation tillage, including no-till, can reduce and slow down the runoff water moving over the field towards the drainage pathway. Even in situations where the fields are mouldboard plowed, a solution as simple as lifting the plow when crossing a known drainage pathway so as not to disturb the ground cover can help protect the soil in these vulnerable zones.

### Advantages

The main advantages of a grassed waterway are as follows:

- the waterway will carry large flows, making it suited to safely carry runoff from large upstream watersheds
- farm machinery can cross it
- once vegetation is established, maintenance is low

### Disadvantages

A grassed waterway also has disadvantages. These include:

- working around the waterway with farm equipment can be difficult
- the waterway lacks the depth necessary to serve as a tile drainage outlet
- establishing vegetation may be difficult

## DESIGN CONSIDERATIONS

### Dimensions

The design of a waterway requires proper determination of the channel's width and depth dimensions for a given channel grade. Building to the proper dimensions ensures that:

- the velocity of the flowing water does not wash out the waterway and
- the capacity of the waterway is sufficient to carry the surface flow from the contributing watershed without overtopping

The allowable velocity of water in the waterway depends upon the type, condition and density of vegetation, as well as the erosive nature of the soil forming it. A uniform vegetative cover is important because the stability of the most sparsely covered area determines the stability of the overall channel. Grasses provide a better vegetative cover than legumes because grasses produce a denser ground cover, resisting water velocity more effectively. The growth stage of the waterway vegetation also affects water flow. Taller vegetative growth in the waterway resists water flow and must be viewed as a critical factor in capacity design. The exception is situations when tall vegetation is uniformly pushed over by the force of the runoff water, creating a smooth mat of vegetation over the channel. The water velocity in the channel may then become a concern.

In summary, waterway dimensions will vary according to the following conditions:

- waterway width and depth increases as the volume of runoff water to be carried increases
- steeper channel grades results in the need to build a wider, shallower waterway
- a highly erodible soil requires a wider, shallower waterway

Design charts are available to assist in selecting proper waterway dimensions. For such detailed design information, refer to OMAFRA Publication 832, *Agricultural Erosion Control Structures – A Design and Construction Manual*.

A more general discussion about critical design elements follows.

### Waterway Shape

A grassed waterway can have a bottom shape that is trapezoidal or parabolic (saucer) shaped. Generally the parabolic form is preferred because such a broad, shallow channel, with the bottom almost flat, spreads the water, slows its velocity and reduces its power to erode. If the waterway is to be crossed with farm machinery, then grade the side slopes to a maximum steepness of 10 horizontal to one vertical.

Errors in constructing waterways include making them too deep, too narrow or too V-shaped. Avoid constructing grassed waterways that are triangular-shaped (V-shaped) because this design is much more susceptible to water flow scour along the waterway's centre, leading to further gully formation.

Trapezoidal-shaped waterways reduce this concern and can enhance a waterway's flow capacity for a given width, but are generally not crossable by farm machinery.



**Figure 2.** A parabolic (saucer-shaped) waterway allows water to spread out and not erode the channel bottom.

### Waterway Grade

Waterways are constructed to closely match the natural drainage way grade where possible. In practice, the most satisfactory grade range has proven to be one to five per cent. With steep grades (greater than five per cent), install a grade control structure (e.g. a drop structure) at critical locations along the waterway to reduce the grade. For excessively steep grades, the waterway centre must be lined with an erosion-resistant material such as rock riprap.

A lack of grade can also be a problem when designing a grassed waterway. When the natural waterway grade

is less than one per cent, either cut more grade or consider alternative erosion control measures.

### Waterway Outlets

Any time surface water is collected or concentrated, such as with a constructed grassed waterway, common law requires the collected water be brought to a "sufficient outlet". A sufficient outlet is defined as a location where the collected water will do no damage to other property owners. If a grassed waterway is not brought to a sufficient outlet, the owner who constructed the waterway could be held liable for the downstream damages that may occur. This is not a concern for those who have a sufficient outlet on their land. For those who do not, there are two methods of acquiring sufficient outlet.

#### 1. Mutual Agreement Drain

The *Ontario Drainage Act*, section 2, allows a group of property owners involved in a shared drainage system to enter into an agreement. The agreement must outline specific details of the grassed waterway and include items on cost-sharing and future maintenance. Once registered on property title, this agreement is binding on all future owners of the involved properties.

#### 2. Municipal Drain

If a shared mutual drainage system cannot be agreed upon, Section 4 of the *Act* allows a property owner to petition their municipality for a shared drainage system, commonly known as a municipal drain. Through this process the municipality appoints an engineer who prepares a report outlining the specifics of the shared drainage system. Once adopted by by-law, the municipality may construct the grassed waterway and assess the costs to the involved landowners. Future maintenance of waterways constructed in this manner is the responsibility of the municipality. For more information, see OMAFRA Factsheet *So, What's a Municipal Drain?*, Order No. 01-059.

### Exits

Grassed waterways often exit into open ditches or streams so the construction of stable, non-erosive outlets at these locations is important. Rock chute spillways or vertical grade-control structures will safely

convey the water from the waterway to the chosen outlet.

### DRAINING THE WATERWAY

Waterways should not be continually wet. If they are, maintaining a good vegetative cover is more difficult and crossing the waterway with farm equipment will cause rutting or become impossible.

#### Subsurface Drainage

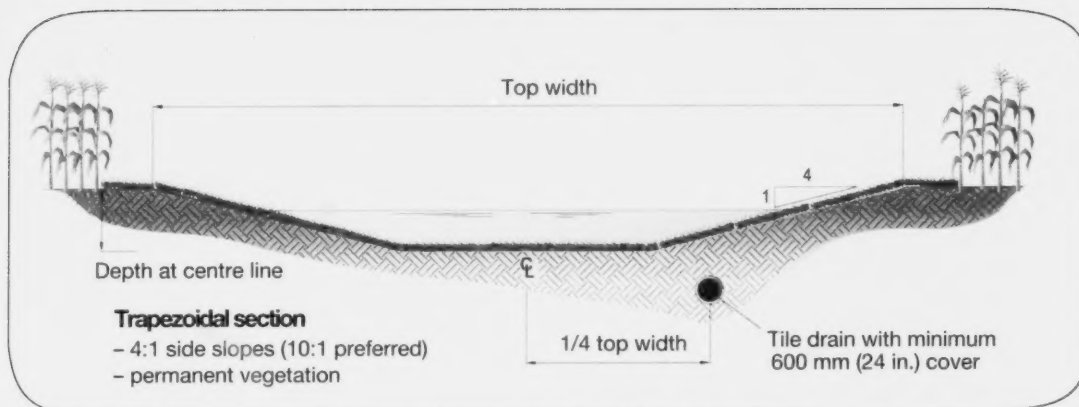
To prevent the waterways from being wet for long periods of time, install tile drainage lines. Each one should be parallel to the centre of the waterway and be offset by a distance of at least one-fourth the top width of the waterway as measured from the waterway's centre line. Depending upon soil type, water table conditions, etc., one or two 100 mm (4 in.) diameter lines per waterway may be required.



**Figure 3.** A rock chute spillway located at the outlet of a grassed waterway

### SURFACE DRAINAGE

Surface water inlets, or catch basins, may have to be installed on the upper end of the waterway and connected to a subsurface tile drain to carry seepage water and/or low flows of surface water underground. This inlet will intercept only a small percentage of the surface water that the waterway carries. Nevertheless, directing the persistent surface seepage water to a tile will result in a drier waterway, improving the quality of the waterway's vegetative cover and permitting the crossing of farm equipment during field operations.



**Figure 4.** Recommended location of subsurface drainage tile beneath a grassed waterway

## WATERWAY CONSTRUCTION

Waterways are constructed with equipment capable of moving and smoothing soil, such as bulldozers, land levellers and road graders. Farm tillage implements can aid in the final smoothing of soil for seedbed preparation. The construction procedure and time involved in constructing a grassed waterway depends upon the topographic features of the area and the construction equipment available. If a waterway is to be located in a natural draw or shallow gully with few washout areas, only minimal shaping and smoothing is needed. On the other hand, if the waterway is to reclaim a larger established gully, considerable earthwork is required.

## Timing

The timing of construction for the grassed waterway is extremely important. A high percentage of grassed waterways have washed out within the first few weeks or first year of construction because they were installed in the late fall when there was not enough time left in the growing season for the vegetation to become established.

- The best time to construct a waterway is late August or early September so vegetation will have formed a good stand before the late fall rains occur.
- Seed the waterway at the end of each construction day. Seeding at this time permits the germination of seed because there is still adequate moisture in the soil. Broadcast the seed with a hand or ATV-mounted cyclone-seeder.

- When using an ATV, travel perpendicular to the waterway. Otherwise, during the critical period of grass establishment, there is a risk runoff water will follow the path made by the indented and compacted wheel tracks along the waterway, encouraging erosion.
- If broadcasting is not possible, the seed can be applied with a drill, but be sure to plant across or partially across the direction of the water flow. Like ATV wheel tracks, farm machinery wheel-tracks, combined with drilled rows parallel to the water flow in a new waterway, encourage erosion.



**Figure 5.** Broadcasting the waterway's grass seed with a hand-operated or ATV-mounted seeder is recommended.

## Protecting Newly-Constructed Waterways

Taking a temporary measure to protect the newly constructed waterway may be required. The need is especially great when risks of possible washout are high. Severe storms occurring prior to vegetative establishment may cause washouts. Consider the following protective measures:

- Construct a temporary diversion at the top end of the waterway to prevent large flows from entering the waterway until the vegetation is established. Use this only where a satisfactory alternate route for surface water exists. Remove the temporary diversion once waterway vegetation is established.
- A straw mulch applied at a rate of 1.5 tons per acre (3.4 tonnes per hectare), immediately after seeding the waterway, can protect the growing seeds effectively. The straw must be anchored. Normally, anchoring is accomplished by crimping, disking, rolling or punching the straw into the soil.

Now, many new materials are on the market for stabilizing the soil surface during the establishment of grass seedlings. Such materials include chemical soil stabilizers, plastic fibre or mesh covers, asphalt mulches and biodegradable mats. These materials serve as:

- mulch to reduce the rate of drying
- barriers to absorb the energy of raindrops or wind
- resistance to reduce the velocity of runoff water

Permeable barriers such as staked straw bales, silt fence and coir logs, placed on the contour at regular intervals and perpendicular to the waterway, can slow runoff water, preventing rilling and washouts. If a large runoff event occurs however, they can be overwhelmed. Remove these temporary barriers once vegetation has established.

## SEEDING AND FERTILIZING THE WATERWAY

Waterway seeding mixtures should include quick growing annuals for temporary control, as well as a mixture of hardy perennials, for permanent protection. Most seed companies have specific seed mixtures for different applications based on such factors as soil drainage, shade tolerance, resistance to flow velocity, maintenance requirements and climatic conditions. See Table 1 for general guidance on

seeding mixtures and rates that have proved successful under a wide range of Ontario conditions.

Do not use grasses that bunch, such as timothy and orchard grass. While tap rooted legumes are rarely recommended alone, alfalfa can provide a satisfactory cover when seeded as part of a grass-legume mixture. This recommendation offers a practical benefit to livestock farms where forage harvesting can include that portion of the crop in the waterway. For further information, on seeding options, refer to OMAFRA Publication 832, *Agricultural Erosion Control Structures – A Design and Construction Manual* or contact your grass seed dealer for local experience with successful erosion control seed blends.

Under most conditions, grasses or grass-legume mixtures can be used as an erosion-resistant cover for water velocities up to 1.2 m per second (4 ft per second). Above this velocity, consider other linings such as rock riprap or permanent erosion-control mats.

**Table 1.** General Waterway Seeding Recommendations

Application	As a % of Mixture	Rate
<b>Permanent Seed</b>		
Creeping red fescue	50	Broadcast at 80 kg/ha (70 lb/ac)
Perennial ryegrass	45	Drill at 50 kg/ha (45 lb/ac)
White clover	5	
<b>Nurse Crop</b>		
Spring or fall grain (rye, wheat, oats, barley etc.)	100	Broadcast at 80 kg/ha (70 lb/ac) Drill at 50 kg/ha (45 lb/ac)
<b>Fertilizer</b>		
For most soils use: 7-7-7		80 kg/ha (70 lb/ac)
Where nutrients may be limiting, consider: 6-24-24 on sandy soil 8-32-16 on clay soil		310 kg/ha (275 lb/ac)

Maintain the soil in the waterway at a moderate to high fertility level and lime according to soil and plant requirements. It is important during construction that topsoil, in areas where shaping or earth cuts need to be made, is stripped and stockpiled and later replaced as the seedbed. This will help preserve the area's fertility. Ideally, broadcast and work the fertilizer in fairly shallow during the final stages of seedbed



preparation. Refer to OMAFRA Publication 811, *Agronomy Guide for Field Crops* and Publication 832, *Agricultural Erosion Control Structures – A Design and Construction Manual* for more details on fertilizer rates for grasses and waterways.



**Figure 6.** A well-maintained grassed waterway will safely move surface water off farmland.

### **MAINTENANCE OF THE GRASSED WATERWAY**

To keep grassed waterways in good repair, they must receive regular attention, especially during the first year after establishment.

- Inspect grassed waterways for damage immediately after heavy rains.
- Repair and re-seed bare or eroded spots quickly.
- Apply fertilizer in periods of the year when runoff risk is low to maintain soil fertility and encourage a thick, vegetative growth.
- Mow the waterway two or three times a year to help thicken the sod.
- Prevent livestock from having access to the waterway.
- Do not use the grassed waterway as a travel lane for either cattle or farm machinery.
- When crossing the waterway, raise farm implements and keep sprayers shut off.
- Plough the surrounding land at right angles to the waterway to allow surface water to flow into the waterway.

- Never plough a headland furrow parallel to the waterway as a gully will develop there in the future.
- Avoid using waterways as “turn rows” during tillage and cultivation operations.
- Follow good tillage and cropping practices on the surrounding farmland to conserve soil, reduce runoff and reduce the accumulation of sediment in the waterway.
- Remove any sediment that may accumulate and eventually clog and destroy the waterway structure.
- Avoid crossing the waterway with heavy machinery when the soils are wet.
- Control noxious weeds.

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